2017 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS)

Design and Implementation of Smart HealthCare System Using IoT

Durga Amarnath M. Budida
Department of Computer Engineering
Bapurao Deshmukh College of Engineering
Sewagram (Wardha) , India
vamarcool11@gmail.com

Dr. Ram S. Mangrulkar
Department of Computer Engineering
SVKM 's D. J. Sanghvi College of Engineering
Mumbai, India
rsmangrulkar@gmail.com

***Abstract*— Diagnosis, and monitoring of health is a very important task in healthcare industry. Due to time constraint, people are not visiting hospitals, which might and possibly lead to a lot of health issues in one instant of time. Predominantly most of the healthcare systems have been developed to predict and diagnose the health of the patients by which people who are busy in their schedule can also monitor their health at regular intervals. Many studies show that early prediction is the best way to cure health because early diagnosis will help and alert the patients to know the health status. Healthcare being a global issue more particularly India being a most populated nation where majority of which live in villages deprived of healthcare facilities on real time basis continuously and regularly. With the increasing use of technology, there is an urgent need to have such a smart health monitoring system that can communicate between network devices and application which will help the patients and doctors to monitor, track and record the patient's sensitive data containing medical information. This paper depicts the idea of solving health issues using the latest technology, Internet of Things (IoT). It presents the architectural review of smart healthcare system using Internet of Things(IoT) which is aimed to provide a Better HealthCare to everyone. Using this system architecture, patient's body parameters can be measured in real time. Sensors collect patients body parameters and transfers that data to Microcontroller ATMEL 89s52 which further transfer that data to the MySQL database server. This MySQL database server manages the data and provides accessibility. The patient can view this data with the help of Android App. Which one can install in Smartphone, or Tablet. If data is abnormal then patient gets notification also care takers will get emergency message. With the help of different decision making algorithms decisions can be made easily and fast and according to it people can have access to the database. The patient can check their medical record Hence, the system provides a Better HealthCare to everyone and error free and smooth communication to patients.**

***Index Terms*—Internet of Things (IoT); ambient intelligence; monitoring; innovations; leveraged.**

I. INTRODUCTION *(HEADING 1)*

Now a days, the internet has become a vital part of our daily life. It has changed how people live, work, play and learn. Internet serves for numerous ideas such as education, finance, industries, entertainment, social networking, shopping, e-commerce etc. The next innovative mega trend of Internet is Internet of Things (IoT). The IoT connects smart objects to the Internet. It can facilitate an exchange of data and bring users processed data in a more reliable and secured way.

The Internet of Things (IoT) is one of the most vital and transformative technologies ever invented. The Internet of Things (IoT) is a megatrend in next-generation technologies that can culminate the complete business gamut and can be thought of as the interconnection of uniquely identifiable smart devices within today's internet infrastructure with extended benefits. These benefits basically include the advanced concatenation of the devices, systems, and services that go beyond machine-to-machine (M2M) scenarios. Therefore, initiating automation is feasible in nearly every domain. The Internet of Things (IoT) is changing much about the world we live in, the way how we drive, how we do purchases and even in healthcare solutions.

Medical care and healthcare represent one of the most attractive application areas of the IoT. The Internet of Things (IoT) has the potential to give rise to many medical applications such as remote health monitoring, fitness programs, incurable diseases, and elderly care. Thus, various medical devices, sensors, diagnostic and imaging devices can be viewed as smart devices or smart objects constituting an interior component of the IoT. IoT-based healthcare services are foreseen to minimize costs, increase and provide a better quality of life, and enrich the users experience.

In order to continuously make our health care services robust immense and secure, the IoT relies on several enabling technologies. Congregating real-time data from different sources, in this case, an unlimited number of patients for a considerable period of time has become very simple and fast using the potential of IoT. The potential of IoT for health and medical services are tackled by smart sensors which accurately measures, monitors and analyze a variety of health status designators. These include basic crucial health signs such as pulse rate and blood pressure. With the help of IoTs potential, doctors are now able to collect real-time raw data from numerous patients for a continual period of time through smart devices connected to an interconnected network, which ensure them not only with trustable and reliable results but also time-saving which will be of maximum benefits. Internet of Things (IoT) is going to revolutionize healthcare by significantly lowering costs and improving quality.

978-1-5090-3294-5/17/$31.00 ©2017 IEEE

II. Related Work

Deepika Agrawal et al.[1]proposed an IoT-based healthcare monitoring system that collects all the medically relevant data of patients, including patients heart rate, blood pressure and ECG and sends alerts to the patient's doctor regarding patients full medical information, providing a fast and reliable health care service.

Sapna Tyagi et al. [2] defined the role of IoT in healthcare deliverance and its technological aspects that make it a reality and examine the opportunities. This system build's a network among all entities (doctors, patients, Labs, Pharmacists, Nurses) participating in healthcare that not only limits to the entities under one umbrella but also covers nationwide entities. Tried to implement the concepts of IoT where these entities would be directly communicating to the cloud.

Alexandru Archip et al. [3] defined the steps taken to design and build a low-cost monitoring system prototype. The system focuses on remote patient monitoring in hospital wards, following an ICU discharge. The system offers mobile support in order to facilitate faster and better medical in emergency cases and has been developed using low-power dedicated sensor arrays for EKG, SpO2, temperature and movement.

S. Sivagami et al. [4] defined a proposal for smart hospital system (SHS), which relies on different, yet complimentary, technologies, specifically RFID, WSN and smart device such as mobile, inter-operating with one and all through a Constrained Application Protocol (CoAP)/IPv6 over low-power wireless personal area network (6LoWPAN)/representational state transfer (REST) network infrastructure. In this proposed system, the sensors are built to get the environmental conditions of the hospital for which hospital staff would be responsible and RFID is used for this monitoring. For the patient, a nurse would be responsible for tracking/monitoring the patient health condition (temperature and heart rate), based on which graphical chart is generated which is shared with the doctor.

Nitha K. P. et al. [5] reviewed the concept, applications and various existing technologies in healthcare. The system uses all the potentialities of Internet of Things(IoT) by enabling connection with smart devices to provide them the best health care and also enumerated the key difference between and brief clarification of the scope of IoT in personalized health care, that ranges from wrist-worn devices to health care systems.

Alex Page et al. [6] proposed that network sensor either worn on the body or embedded in a living environment that can help in providing rich information captured on a continual basis which is aggregated and effective minded about the patients physical and mental health. They have proposed a system where the data acquisition is performed multiple wearable sensors that measures physiological biomarkers such as ECG, skin temperature, respiratory rate, EMG muscle activity and posture. A ZigBee or Bluetooth is used to transfer sensor data to the concentrator. Often a storage/processing device in a locus of a mobile client referred to as a cloudlet, is used to augment its storage/processing capability whenever the local mobile resources do not fulfill the applications requirements. The cloudlet can be a local processing unit (such as a desktop computer) which is directly accessible by the concentrator through WiFi network. Also addressed about the cloud-based medical data storage and the upfront challenges. Analytics that use the sensor data along with e-Health records are becoming prevalent can help with diagnoses and prognosis for a number of health conditions and diseases and additionally, the visualization is a key requirement for any such system. This treasure trove of data, when analyzed and presented to physicians in easy-to-assimilate the visualization that have the potential for drastically improving healthcare and reducing costs. Also highlighted several challenges in sensing, analytics, and the visualization that need to be addressed before systems can be designed for seamless integration into clinical practice.

S. M. Riazul Islam et al. [7] proposed an intelligent collaborative security model to reduce security risk; discussed how different innovate technologies such as big data, ambient intelligence, and wearables are leveraged in a healthcare context; addressed various IoT and eHealth and regulations around the world. Furtherly, analyzed the distinct IoT security and privacy features, as well as including security requirements, threat models, and attack taxonomies from health care perspectives and defined the advances in IoT-based health care technologies.

Danilo De Donno et al. [8] proposed A novel, IoT-aware, sharp-witted architecture for automatic monitoring and tracking of patients, personnel and biomedical devices within the hospitals and nursing organizations. Staying true to the IoT vision, they proposed a Smart-Health-System (SHS) which relied on different, yet complementary, technologies, specifically RFID, WSN, and smart mobile technologies.

Cecilia Occhiuzzi et al. [9] proposed An Ambient Intelligence platform, denoted as NIGHTCare for remote monitoring and control of overnight living environment which is entirely based on RFID passive technology which is bale to recognize nocturnal behaviors and activities, generates an alarm to the operators, families, or towards first-aid remote centers in case of anomalous or pathological events and support diagnostics. The NIGHTCare platform deploys miniaturized wearable tags (WT) properly integrated in the clothes, conventional ambient tags (AT) disseminated in the environment, a long-range UHF RFID reader, a web-based graphical processor with warning modules and a physical layer software engine for real-time processing. By processing the electromagnetic signals which are arising from the interaction between the subject and surrounding environment, system detects and reports the presence or the absence of the user in the bed, his/her jerky movements and the motion patterns, accidental falls, prolonged absence from the bed and prolonged periods of inactivity such as fainting, unconsciousness or even death.

Mohamed Adel Serhani et al. [10] proposed a frame work to collect patients data in real time, in order to perform appropriate nonintrusive monitoring and propose medical and/or lifestyle engagements, whenever needed. The framework completely relies on service-oriented architecture (SOA) and the cloud which allows seamless integration of

mobile technologies and services to smoothly collect the vital data for the patients wearable biosensor devices. The data are stored in the cloud which and made available that can be accessed by the physicians and/or by any other authorized entity.

Hasmah Mansor et al. [11] proposed a health monitoring system which helps the doctors to monitors the patient's health vital signs via web. Designed and developed the body temperature measurement device that helps the doctors to measure the patient vital signs via the internet and as well as to trace the patients history which indicates an alarm to the doctors in case of abnormality signs in patients health.

Ming Li et al. [12] proposed a novel patient-centric framework and a suite of mechanisms for data access control with the PHR stored in semi-trusted servers in order to achieve fine-grained and scalable data access control for PHRs by leverage attribute-based encryption (ABE) techniques in order to encrypt every patient's PHR file. Made focus on multiple data owner scenarios and has divided the user in the PHR system into multiple security key management which gradually reduces the key management between the users and the owners. A good number of patients privacy is guaranteed simultaneously by exploiting multi-authority ABE that enables dynamic modification of access policies or file attributes, supports efficient on-demand user/attribute revocation and break-glass access under emergency scenarios.

Yi Mao et al. [13] proposed an early warning system (EWS) designed to identify or to trace the signs of clinical deterioration and provide early warning for serious clinical events. Also introduced a bucketing technique that identifies and captures the changes in the vital signs. Meanwhile, managed to handle the missing data so that the visit who dont have all the parameters can still be classified. Conducted a pilot feasibility study by using an amalgamation of logistic regression, bucket bootstrap aggregating for addressing over fitting, and exploratory under sampling for addressing the class imbalance. Also showed that this combination can significantly improve the prediction accuracy for all performance metrics, over other major methods.

Pragati Gupta et al. [14] described the wireless sensor network and its application to wearable physiological monitoring system. In these physiological monitoring system, the sensors are integrated at certain locations on the vest and are interconnected to the wearable data acquisition hardware by wires woven into the fabric. But the main drawbacks associated with these systems are the cables woven in the fabric collects noise which results in corrupting the physiological signals. Also repositioning of the sensors in the fabric is difficult once integrated. So in order to overcome with this physiological monitoring sensors must be designed by miniatures electronics which must be placed strategically at various locations of the vest. A Number of sensors integrated into fabric form a network (Personal Area Network) and interacts with the human system to acquire and transmit the physiological data to wearable data acquisition system. The wearable data acquisition hardware accumulates the data from various sensors and transmits the processed data to the remote monitoring station.

George Ganiatsas et al. [15] developed a system named AUBADE from the University of Ioannina in Greece, a wearable device that performs an evaluation of the emotional state of a discrete targeting environments, where human subjects operate at extreme stress conditions. The model consists of a mask containing sixteen EMG textile fire proof sensors, a three-lead ECG, and respiration rate sensors located on the chest and a textile sensor measuring electrodermal activity(or lively skin response or skin conductance activity) placed inside a glove. A 3-D facial representation and an intelligent emotion recognition module have been implemented for classifying the individual's psychological condition from a set of emotions.

Robert Matthews et al. [16] derived a description and evaluation of a wireless version of a system based on these innovative ECG sensors. Developed a new class of miniature, ultra low noise, wearable and ultra low power wireless capacitive sensor node called Eco that does not require direct contiguity to the skin, and has equivalent performance to gold standard ECG electrodes.

Yunxia Chen et al. [17] derived a general formula for the lifetime of wireless sensor networks that holds the underlying network model including network architecture and protocol, data collection initiation, lifetime definition, channel dwindling characteristics, and energy consumption model which identifies two key parameters at the physical layer that affects the network lifetime. Based on this formula, they have proposed a medium access control protocol that utilizes both the channel state information and the residual energy information of individual sensors.

Rita Paradiso et al. [18] proposed a system based on a textile wearable interface which is implemented by integrating sensors, electrodes, and connections in fabric form, innovative signal processing techniques, and modern telecommunication systems. The system shows the feasibility of a system based on fabric sensing elements. Designed for monitoring individuals affected by cardiovascular diseases, in particular during the reformation phase. The system can also help professional personnel's who are subjected to considerable physical and psychological stress, environmental and professional health risks.

III. Proposed Work

The proposed system aims to cover an end-to-end smart, efficient and innovative health application that can be built up with two functional building blocks. However, the main function of the first building block is to gather all sensory data that are related to the monitoring of the patients, whereas the second block function is to store, process and present the resulted information on the server where the doctors can access health reports following the case of the monitored patients.

As shown in Figure 1, which illustrate the overall model, the system consists of a robust health monitoring system that is intelligent enough to monitor the patient health automatically

using IoT. This would help the doctors to monitor patient's report from anywhere and at anytime.

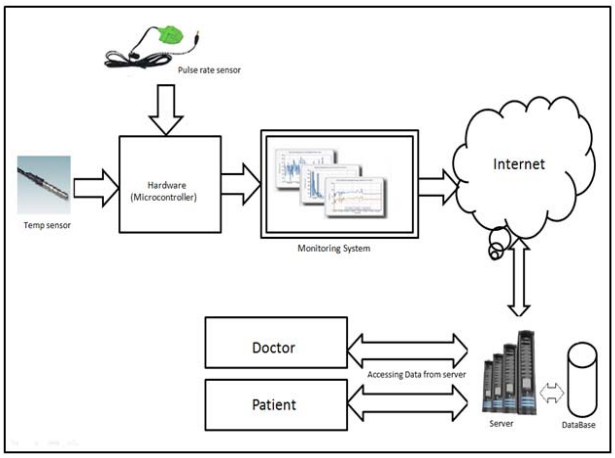

Figure 1: Proposed Block Diagram of IoT based Smart HealthCare System

The system uses smart sensors that generate raw data information collected from each sensor and send it to a data server where the data can be further analyzed and converted into a graph analysis and statistically maintained at the server which can be used by the medical experts.

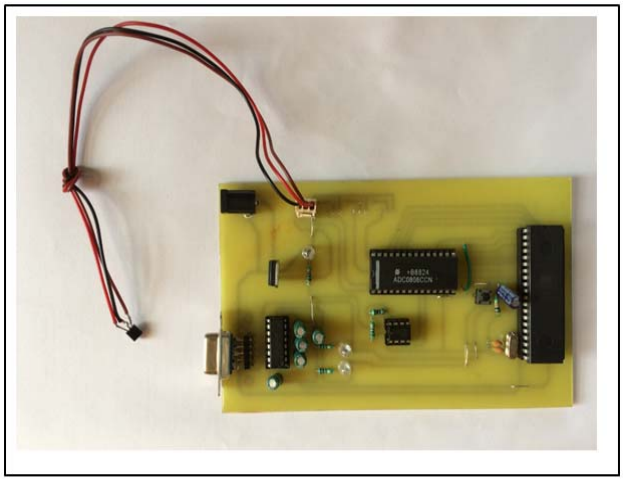

Figure 2: Experimental Circuit Setup

As depicted in Figure 2, and said above the proposed system is an integrated system and combines an excellent means of diagnosis by the fusion of hardware and software. The components related to hardware include: The components related to hardware include:

- Microcontroller ATMEL 89s52.
- Temperature sensor.
- Pulse rate sensor.
- RS-232.
- Analog-to-digital converter.
- Voltage regulator IC-7805.

The hardware is rightly and perfectly complemented with a right blend of software to form a highly evolving system in the field of health. Microcontroller ATMEL 89s52 is the 40-pin DIP which is the brain of the model which governs all the functions. It collects the input data from the sensor such as temperature sensor, a pulse rate sensor etc. and sends the data that is detected by the sensors while connected to the patients and this data is forwarded to the analog-to-digital converter which converts the analog data into digital data. This data is then uploaded to the web server. The uploaded data can be viewed by doctors as well as patients through a web page and android application. The web page and android application are provided with additional features such as:

- Booking doctors appointment according to area and specialization.
- Emergency push button.
- Medical alert.
- Patient's feedback.
- Single and Family registration.
- Access health data from anywhere.

Let's doctor provide patient referral to other doctor.

The voltage regulator IC 7805 is the integrated circuit. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator IC 7805 maintains the output voltage at a constant value. It provides +5V regulated power supply.

The software and hardware mutually interact with each other to form a complete health diagnostic system. The patient and doctor are provided convenience to access and mutually benefit each other. At the time of extremity situation alert message is sent to the doctor. Hence quick provisional medication can be easily done. This system is much cost effective with low power consumption capability, easy setup, high performance and time to time response.

IV. Experimental Results

The proposed smart health monitoring system is being deployed and tested over a patient whose personal details are entered into the web portal. The patient is connected to the smart health monitoring system which consists of a heart rate sensor, blood pressure and a temperature sensor. The live graph of the patients heart rate, blood pressure and a temperature is being monitored on a Wamp based database server. The IOT device used here is Microcontroller ATMEL 89s52 and sensors. The system architecture of the proposed model is explained by the given figures which include a server connected Microcontroller ATMEL 89s52 that uploads the data received by the sensors onto the database and statistical graphs are being plotted for further analysis and records.

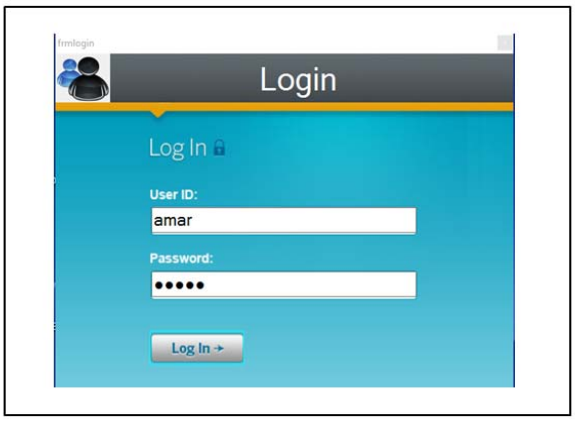

Figure 3: Administrator Login

In the login page, the user can get login into his own page either as a doctor or as a patient according to the credentials given.

Figure 4: Home Page

The home page of the web portal consists of various tabs such as login, registrations, view patient details etc.

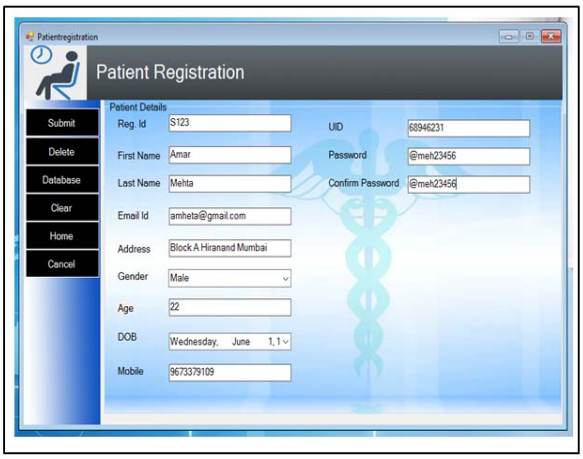

Figure 5: Patient Registration

The admin page allows the patient to enter the personal details such as Name, Date of Birth, Blood Group, Address and various more essential details in order to systematically maintain the records.

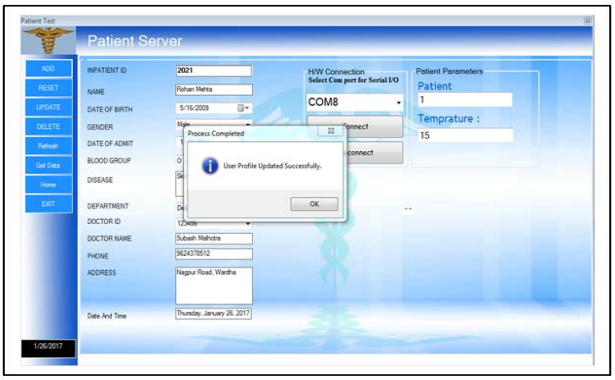

Figure 6: Patient details are added successfully

In the ADD tab, the patient blood pressure, heart rate and temperature sensors are added into the database server with the unique user ID so as to maintain the records for further purpose.

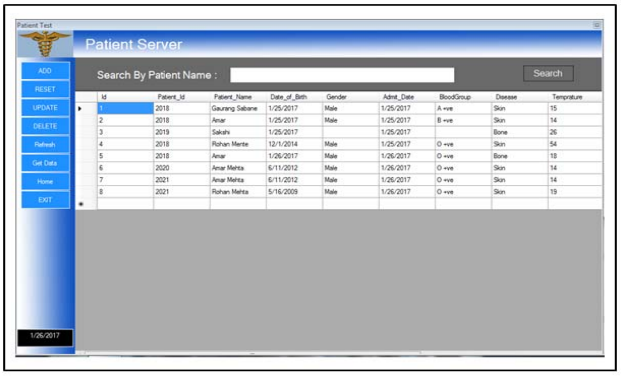

Figure 7: Uploaded Data

The data from the various sensors are uploaded in the database server which is been further used to analyze the health reports and to plot a graph.

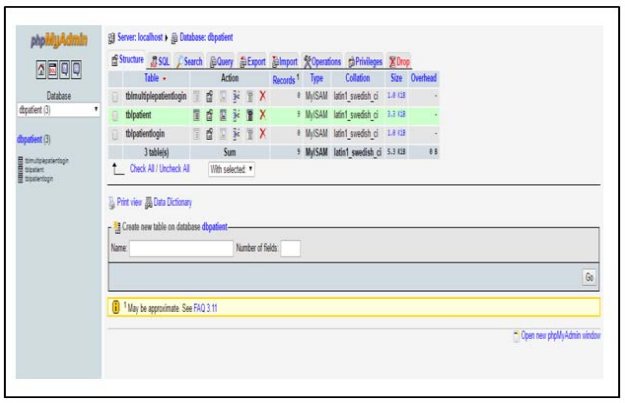

Figure 8: Database Server

This figure shows the complete structure of the database server which is being hosted currently on the local host and further can be connected globally via IoT. The database server has detail record of each and every patient through which a statistical graph is plotted in real time which is used for patients further analysis and tracking.

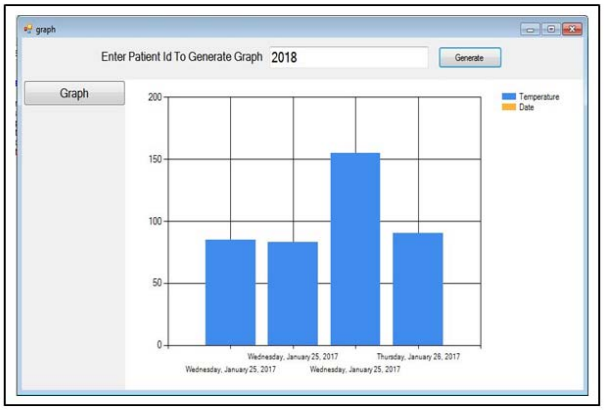

Figure 9: An Example of Health Monitoring Graph

V. Conclusion

The internet has immensely changed the way we live, intercommunicating between people at a virtual level in several contexts spanning from professional life to social relationships. The IoT has the potentiality to add a new dimension to this process by establishing communication among smart objects, leading to the vision of anytime, anywhere, any media, anything communication. Ingenious use of IoT technology in healthcare not only bring benefits to doctors and managers to access wide ranges of data sources but also challenges in accessing heterogeneous IoT data, especially in a mobile environment of real-time IoT application systems.

Considering the population status and the majority of the people live in villages which are remote places and with the growing technology and more importantly healthcare being the predominant issue of the nation this smart healthcare system using IoT technology plays an important monitoring tool at levels in the larger interest of the global as a whole.

The health monitoring system is beneficial to the patients as well as to the society where the implementation of such systems will save hospital bill, waiting time, and also reduce the long queues in the hospitals.

This paper tries to emphasize on a healthcare system which is enabled with IoT technology that not only realizes the illustration and traceability of healthcare actors but guarantee the improved health care services. The key motive behind the proposed system is to provide better and efficient health services to the patients by implementing networked information so that experts and doctors can make use this data and could provide fast and efficient solution. Thus, this technology provides solutions to healthcare issues and connects the patients across the country and also doctors to monitor, track and record patients vital data and medical information on real time basis so that timely and effective solutions to the patients on regular basis.

Acknowledgment

I would like to acknowledge my indebtedness and sincere gratitude to my guide for his invaluable guidance during my dissertation work and my family for the encouragement, support and kind co-operation. And all the staff members of Computer Science and Engineering department, Bapurao Deshmukh College of Engineering for providing me excellent atmosphere for dissertation work.

References

[1] Deepika Agrawal, Punit Gupta, Jasmeet Chhabra and Pulkit Kumar Dhir, “IoT based Smart Health care Kit”, International Conference on Computational Techniques in Information Technologies, July 2016.

[2] Sapna Tyagi, Amit Agrawal, Piyush Maheswari, “A Conceptual framework for IoT-based Health care System using Cloud Computing”, Sixth International Conference Cloud System and Big Data Engineering, July 2016, pp. 503-507.

[3] Alexandru Archip, Nicolae Botezatu, Elena Serban, PaulCorneliu Herghelegiu and Andrei Zal, “An IoT Based System for Remote Patient Monitoring”, Senenteenth International Carpathian Control Conference, June 2016, pp.1-6.

[4] S.Sivagami, D. Revathy and L. Nithyabharathi, “SMART HEALTH CARE SYSTEM IMPLEMENTED USING IoT”, International Journal of Contemporary Research in Computer Science and Technology, vol. 2, Issue 3, March 2016.

[5] Nitha K P and Sreekanth K U, “A Study on Health Care in Internet of Things”, International Journal on Recent and Innovation Trends in Computing and Communication, vol. 4, pp. 44-47, February 2016.

[6] Moeen Hassanalieragh, Alex Page, Tolga Soyata, Gaurav Sharma, Mehmet Aktas,Gonzalo Mateos,Burak Kantarci and SilvanaAndreescu, “Health Monitoring and Management Using Internet-of-Things (IoT) Sensing with Cloud-based Processing: Opportunities and Challenges”, IEEE International Conference on Services Computing, August 2015, pp. 285-292.

[7] S. M. Raizul Islam, Daehan Kwak, MD. Humaun Kabir, Mahmud Hossain and Kyung-Sup Kwag, “The Internet of Things for Health Care: A Comprehensive Survey”, IEEE Access, vol.3, pp.678-708, April 2015.

[8] Danilo de donno and Luca Palano, “An Iot-Aware Architecture for Smart Health care System”, IEEE Internet of Things Journal, vol. 2,Issue 6, pp. 515-526, January 2015.

[9] Cecilia Occhiuzzi , Carmen Valleseb, Sara Amendolab, Sabina Manzarib and Gaetano Marroccob, “NIGHT-Care: a passive RFID system for remote monitoring and control of overnight living environment”, Fifth International Conference on Ambient Systems, Networks and Technologies, June 2014, vol. 32, pp. 190-197.

[10] Abdelghani Benharref and Mohamed Adel Serhani, “Novel Cloud and SOA-Based Framework for E-Health Monitoring Using Wireless Biosensors”, IEEE Journal of Biomedical and Health Informatics, vol. 18, No. 1, pp. 46-55, JANUARY 2014.

[11] Hasmah Mansor, Muhammad Helmy Abdul Shukor, Siti Sarah Meskam, Nur Quraisyia Aqilah Mohd Rusli and Nasiha Sakinah Zamery, “Body Temperature Measurement for Remote Health

Monitoring", IEEE International Conference on Smart Instrumentation, Measurement and Applications, Nov. 2013.

[12] Ming L, Shucheng Yu, YaoZheng, Kui Ren,and Wenjing Lou, "Scalable and secure sharing of personal health records in on cloud computing using attribute based encryption", IEEE Transactions Parallel Distributed System, vol. 24, no. 1, pp. 131-143, Jan. 2013.

[13] Yi Mao, Yixin Chen, Gregory Hackmann, Minmin Chen, Chenyang Lu, Marin Kollef, and Thomas C.Bailey, "Medical data mining for early deterioration warning in general hospital wards", IEEE 11th International Conference on Data Mining Workshops (ICDMW), Dec 2011, pp. 1042-1049.

[14] P.S. Pandian, K.P. Safeer, Pragati Gupta, D.T. Shankuntala, B.S. Sundersheshu and V.C. Padaki, "Wireless Sensor Network For Wearable Physiological Monitoring", Journals of Networks, vol. 3, no. 5, May 2008.

[15] C.D.Katsis, George Gianatsas,and D.I. Fotiadis, "Anintegra ted telemedicine platform for the assessment of affective physiological states", Diagnostic Pathology, vol. 1, p. 16, Aug. 2006.

[16] Robert Matthews, Chulsung Park, Pai H. Chou, Ying Bai and Andrew Hibbs, "An Ultra-Wearable, Wireless, Low Power ECG Monitoring System", Biomedical Circuits and Systems Conference, BioCAS 2006, IEEE, pp. 241-244, Nov.2006.

[17] Yunxia Chen and Qing Zhao, "On the Lifetime of Wireless Sensor Networks", IEEE Communications Letters, vol. 9, no. 11, pp. 976-978, Nov. 2005.

[18] Rita Paradiso, Giannicola Loriga, and Nicola Taccini, "A Wearable Health Care System Based on Knitted Integrated Sensors", IEEE Transactions Information Technology In Biomedicine, vol. 9, no. 3, pp. 337344, September 2005.